THE COGNITVE COST OF CHATTING WHILE ATTENDING A LECTURE: A TEMPORAL ANALYSIS

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ABSTRACT

It is common to see students multitasking or switching between different tasks on the computer while also listening to the teacher lecture in the front of a classroom. In today's classrooms, students have much greater control over how they use their time, with the classroom integration of computers and mobile devices combined with social media and text-based chat tools. It is important to understand how students learn with the connected technologies. This study examines high-school students' ability to take notes and obtain information from a video while simultaneously carrying a conversation online with a friend.

KEYWORDS

Cognition; learning; digital technology; multitasking; chat

1. INTRODUCTION

This study examines issues related to media multitasking and learning in educational environments. The rise of connected devices in the classroom has increased the level of multitasking during lectures and lessons. Students are often observed taking notes while texting a friend on their phone or updating their Facebook page. Students can be observed performing these types of dual-tasks throughout the day and it has become a natural part of how they function. What is the cognitive cost of this practice?

Poldrack and Foerde (2007) found that people had a harder time learning new things when their brains were distracted by another activity. The Functional Magnetic Resonance Images (fMRIs) used by researchers showed that when people learned without distraction, an area of the brain known as the hippocampus was involved. This region of the brain is critical to the processing and storing of information. However, the hippocampus was not engaged when people learned while multitasking. Instead, the region of the brain called the striatum was activated. The striatum is activated by stimuli associated with reward or by stimuli associated with aversive, novel, unexpected or intense experiences (Schultz, 2010). Results indicated that learning while distracted or multitasking would alter the brain's learning processes and change the way people learn (Poldrack & Foerde, 2007). Foerde, Knowlton, and Poldrack (2006) found that learning new things is dependent on working memory where as habit learning is not as sensitive to working memory. Some tasks such as learning new skills may require high cognitive loads, while other familiar and automatic tasks may require lower cognitive loads. Lin and Bigenho (2012) examined undergraduate student's memory recall under nine conditions in a 3x3 study with three levels of environmental distraction and three levels of note-taking. The study found significant interactions between environment and method of note-taking as the computer seemed to mediate the effect of an auditory distraction during computer aided note taking. The study also found that students were more successful when taking notes at lower levels of distraction and that those who did not take notes consistently performed poorly on the recall tasks regardless of distraction level.

2. THE STUDY

This study was designed to examine high-school students' abilities to take notes and obtain information of a video while carrying a conversation online with a friend at the same time. The experiments were designed to imitate the practice of chatting online with friends while attending a classroom lecture. Two scenarios were created: one was to have students watch a video and take notes of the video only; another was to have students watch a video and take notes of the video while chatting with a friend. Specifically, students observed a 20-minute video lesson and were told they would be tested on the content of the video after each lesson in both scenarios. The students were also encouraged to take notes following a format and method most comfortable to them. The difference lies in the online chat: in one scenario, the students focus on the video and take notes only; in another scenario, the students maintain a chat with an Artificially Intelligent (AI) agent while observing the video and taking notes. Two videos of the same length and difficulty level were used. All students participated in both scenarios. In addition, four conditions were created so that the sequence of the videos and the sequence of the chat/no chat situations would not affect the results of the study. Data were collected from the student participants' quiz scores of the videos, their notes, and their chat transcripts. The participants were also asked to fill out an open-ended questionnaire to describe their experiences with the experiment and their learning habits. The study employed both quantitative and qualitative measures following a repeated measures design.

Questions we hoped to answer through this approach include:

- What were the patterns, if any, to the distribution of notes as compared to the presentation of the video lecture and the level of chat activity during the chat condition?
- What were the patterns, if any, in the answers on the quizzes as related to the flow of the lectures, the notes that were taken, and the level of chat activity in the chat condition?
- How might the lecturer's style and method of delivery affect the notes recorded, the level of chat activity or the participant's ability to recall information?
- What does this indicate about the nature of the topics and the methods of delivery of the information in increasingly complex and connected classrooms and meeting centers?

2.1 Participants

Participants in this study were from a small to mid-sized independent high school in the Southwest United States. An a priori analysis was conducted from the initial study and it was determined that 40 to 54 participants would allow us to detect a medium effect of $f = 0.25$ with the alpha level set at $p < .05$. A total of 39 students participated in the study. They ranged in age from 15 to 18 with the average being 17 years. All participants were in 9^{th}, 10^{th}, 11^{th}, or 12^{th} grade. Participant consent and assent forms were obtained for each participant.

The experimental conditions, data sources and design are summarized in table 1. This format allows for the following comparisons: video presentation order (First::Second); video topic (Video Topic 1::Video Topic 2), and Chat (Chat::No Chat). Each participant was assigned to a condition and completed all tasks related to that condition. There are two scenarios (Chat/No Chat) which are presented in a balanced format to help identify any effects of video content and presentation order.

Table 1. Sequence and Number of Participants in Each Condition

Conditions	First video and quiz	Second video and quiz	Survey	Number of participants
Condition A	Video A (No Chat)	Video B (Chat)	Post Survey	10
Condition B	Video A (Chat)	Video B (No Chat)	Post Survey	10
Condition C	Video B (No Chat)	Video A (Chat)	Post Survey	10
Condition D	Video B (Chat)	Video A (No Chat)	Post Survey	10

2.2 Data Analysis

The study generated several different artifacts as data and consisted of both qualitative and quantitative data forms. Additionally, the video lessons provided a time code that could be aligned with each data type allowing for all data to be examined across the temporal continuum of the video lesson.

Video Transcript: Each video transcript was organized into sentences with the video on happiness resulting in 256 sentences compared to 184 for the video on energy. This allowed the note and quiz data to be mapped directly back to the video transcript using what we called knowledge units. Knowledge units are a count of specific mappings from the notes to specific sentences.

Notes of the videos: Participants took notes during each of the video lectures recording content from the video lectures. Notes were taken on a computer or on paper as decided by each participant. Notes were coded according to the knowledge units they contained. Each knowledge unit was mapped to specific sentences from the transcript providing a temporal scale to the notes in relation to the content of the video. Data were then loaded into Atlas.TI for future analysis of patterns. A scaled score for comparison between videos was created by dividing the total number of knowledge units recorded for each set of notes by the total number of knowledge units (sentences) in each transcript. This value was multiplied by 100 resulting in a scaled score.

Post video lecture quiz: At the end of each video lecture, the participants were given two minutes to review their notes and then were asked to take a short quiz on the material from the lecture. The questions were directly related to material presented in the lecture they had just observed. The quiz results were subjected to an item analysis and then the results were mapped back to the video's temporal scale and compared with the analysis of the temporal analysis of the notes taken.

Chat transcript: Chatting with the AI chatbot created a transcript of the exchange. Each chat transcript was archived preserving the content of the conversation. Each transcript has a time code embedded and all chats were all initiated with the same method so that they were aligned with the time-code of the video lecture. The units of analysis for the chat were the individual transmissions and frequency of transmission mapped to the video temporal scale. Chats were also analyzed for content and any emerging trends.

Post experimental survey: This was an open-ended questionnaire that all participants completed at the end of each experiment. The survey asked the participants about their experience during the two experimental trials. There was no timestamp for this data. The post survey results were subjected to content analysis using the word as the unit of analysis.

2.3 Result

Using a paired t test, the analysis of the chat/nochat conditions indicated significant differences for quiz scores in the two conditions $t(37) = -5.12$, $p<0.001$ as well as significant differences for knowledge units recorded in notes $t(37) = -4.02$, $p<0.001$. Additionally, the analysis of knowledge units recorded for each video topic also indicated significant differences $t(37) = 3.53$, $p=.001$. There are no significant differences for the presentation order of videos or chat. Additionally, quiz results based on video topic indicated no significant differences.

Table 2. Table of means for comparisons. Items reaching levels of significance using paired t-tests are indicated with **.

Data Type	Comparison	Condition	Mean	S.D.
Quiz Scores	Video Topic	Happy Video	11.28	2.33
		Energy Video	10.74	2.28
	Video Order	First Video	11.39	2.07
		Second Video	10.64	2.49
	Chat Condition**	Chat	9.87	2.35
		No Chat	12.15	1.59
Mapped Knowledge Units	Video Topic**	Happy Video	9.75	5.53
		Energy Video	13.75	6.40
	Video Order	First Video	13.12	6.06
		Second Video	10.41	6.28
	Chat Condition**	Chat	9.55	5.38
		No Chat	13.95	6.39

Comments from the post experimental survey indicated elevated intrinsic interest in the happiness video compared to the energy video while the number of knowledge units recorded in participant notes was higher for the energy video . This may have been linked to less familiarity or comfort with the energy topic and therefore the perceived need to record more notes. However, since the difference in quiz scores between the two video topics did not reach significance, we can treat them as equal when comparing them in the two chat conditions. Additionally, we can ignore video order as it did not reach significance.

Therefore, when students were in the chat condition, they performed significantly worse on the quiz immediately following the lesson, indicating that chatting during the lecture had a significant effect on their ability to code the information and commit the information to short-term memory. Since students were also allowed two minutes to review their notes prior to testing, it would seem logical to believe that their notes were also significantly different between the chat and no chat condition. This conclusion gets increased support when examining knowledge units mapped from notes taken under each chat condition. Students recorded more knowledge units when not in the chat condition than they did when chatting.

The large standard deviations in the findings related to mapped knowledge units were likely the result of some students taking minimal notes during the lecture and not taking notes at all during the chat condition even though they were instructed to do so. Some initial qualitative analyses of the notes and chat transcripts indicated that: 1) there were differences in the use of language between notes taken when chatting and without chatting, 2) there were cases of chat transaction ending up in notes, 3) the chat transactions may serve as indicators for the level of engagement.

The initial results showed that performing a secondary task such as chatting during a video lecture: 1) may reduce the volume of notes taken by over 30%, 2) negatively affected the participant's short-term memory of the video content, and 3) may change the notes by adding multiple sources including the chats into the notes on the video content. The complete data results will be reported at the conference.

3. CONCLUSION

The number of portable connective devices continues to increase in classrooms resulting in a need to understand the effects of using these devices while attending to lessons in the classroom. Also, as the number of online learning opportunities increase, so does the access to opportunities to perform multiple tasks during a lesson. This includes both educationally designed uses of these technologies for learning as well as the non-instructional student mediated use of these technologies. Quantitative results indicate that student's short-term recall was negatively impacted with student-mediated use of these technologies along with the amount of information that was actually captured in student notes while chatting during a lecture. We are also performing a temporal analysis where we will be able to examine trends that emerge from across the different data strands. This type of temporal analysis could provide a further window into what is going on behind the numbers and help us understand why some information is retained while other information is not as students attend to media multitasking during lectures. We hope that this specific contribution to the field will help provide evidence that can inform the effective use of these technologies as well as lesson design and delivery. At the end of each trial, participants completed a short assessment to see what they retained in short-term memory. While long-term memory is the objective of any learning endeavor, we believe that short-term memory is on the path to long-term memory and must be understood in the context of multitasking during learning activities.

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